Summer 2019 Project 6: Manual Strategy

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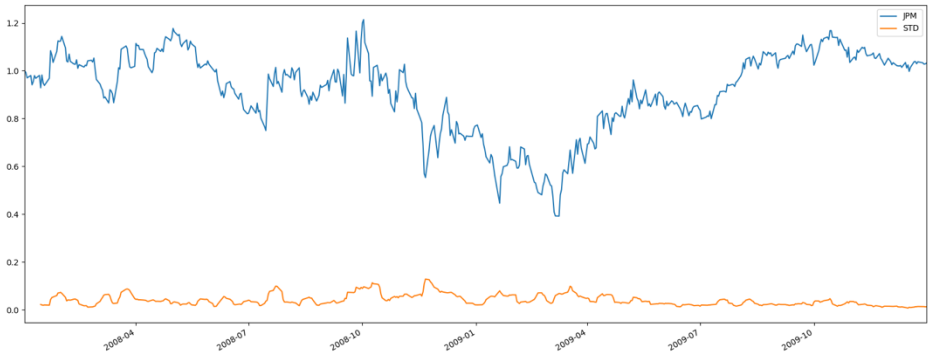
Technical indicators

In this project, I create four different indicators to determine my strategy in the stock market.

1. Volatility indicator

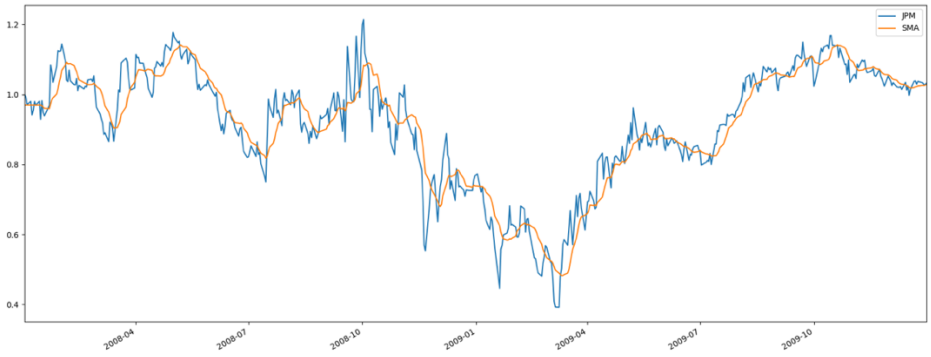
   I calculate standard deviation of daily return for this volatility indicator. It indicates how volatile the price changes during the period of time. When the volatility is high, the stock price change in a wide range. In this case, strategy based on historical data of the stock may be more risk. When the volatility is low, the stock price change in a narrow range. In this case, strategy is less risk.



2. Simple Moving Average (SMA) indicator

   SMA is a trend indicator. It smoothens the price changes by taking the average over some period. When SMA goes up, it indicates the stock price will go up, and vice versa. The wider window frame gives more smooth average. I calculated the SMA by computing rolling mean of prices during window frame as sum of the adjusted closing prices for the number of day during the period and divided by the number of days. In this project, I use 10-day window frame to calculate SMA.

   SMA = adjusted closing prices.sum(t)/ number of days



3. Bollinger Bands indicator

   Bollinger Bands are a volatility indicator. It plotted two lines at 2 standard deviations of daily return on either side of simple moving average line (central line).

   1). Upper band = SMA + 2 * standard deviation of daily prices

   2). Central line = SMA = adjusted closing prices.sum(t)/ number of days

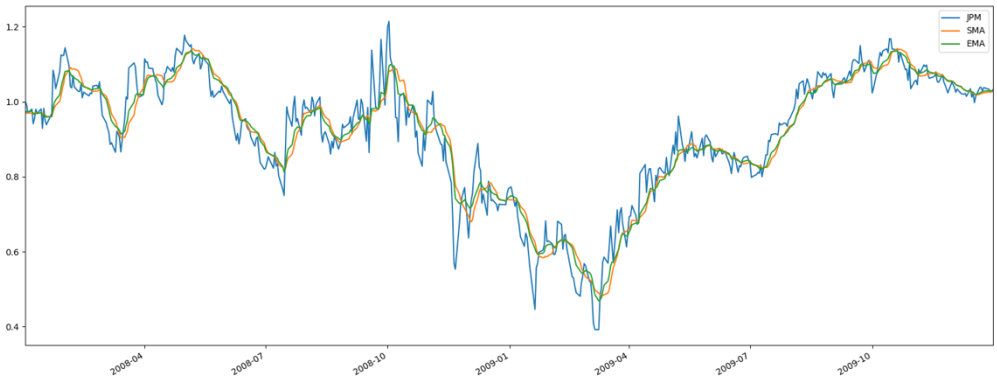
   3). Lower band = SMA - 2 * standard deviation of daily prices

   When the band is narrow, the stock is stable. Its price changes within a small range. When the band is wide from the central line, the market is volatile. Its price fluctuates up and down in bigger range.

   Bollinger Bands also indicate a buying opportunity when price line crosses from outside of the lower band to get back to central line, and a selling opportunity when price line crosses from outside of the upper band to get back to central line.

4. Exponential Moving Average (EMA) indicator

   EMA is also a trend indicator. It is similar as SMA but it gives more weight to recent price data than SMA does. SMA gives the same weights for all previous data. Since EMA gives more weights on recent data, it is more sensitive to the latest price changes.



   There are 3 steps to calculate EMA:

   1). Calculate the SMA = adjusted closing prices.sum(t)/ number of days

2). Calculate the multiplier for weighting the EMA = 2 / (number of days + 1)
3). Calculate the current EMA = Price(*today*) × *multiplier* + *EMA*(*yesterday*) × (1− *multiplier*)

	JPM	SMA	EMA
2008-01-02	1.000000	0.969769	0.969769
2008-01-03	0.992982	0.969769	0.973989
2008-01-04	0.970367	0.969769	0.973331
2008-01-07	0.980244	0.969769	0.974588
2008-01-08	0.941253	0.969769	0.968527
		...	
2009-12-24	1.037432	1.023993	1.028349
2009-12-28	1.033273	1.025890	1.029244
2009-12-29	1.027554	1.025188	1.028937
2009-12-30	1.028594	1.026852	1.028875
2009-12-31	1.031973	1.027606	1.029438

The table above shows the difference between SMA and EMA compared to stock prices. It is clearly see that EMA is always closer to the prices than SMA.

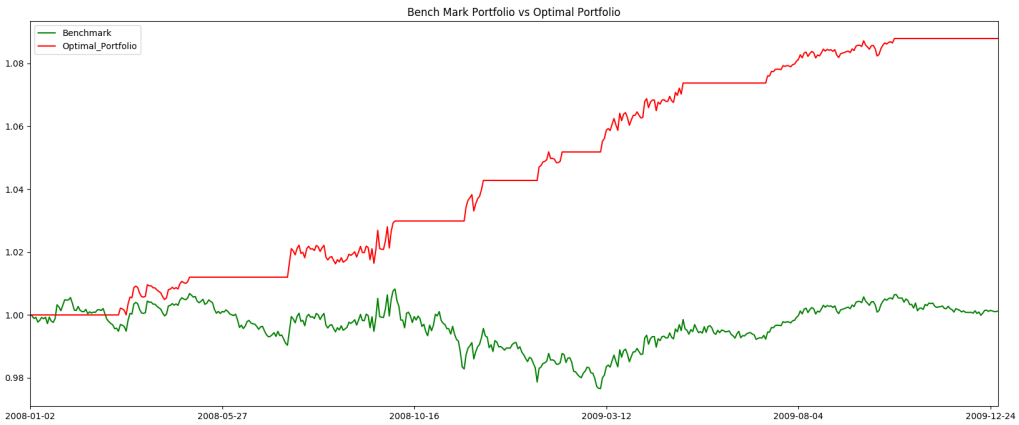
Theoretically Optimal Strategy

For optimal portfolio, assuming I can see the future and with all constrains and limitations, I choose to pick 6 days at local bottom of price line and 6 days at local top of price line during the sample period. I buy 1000 shares of JPM stock at each local bottom day and sell 1000 shares at the next local top day. I make profit for each pair of trades.
Table below lists the details of order trades for optimal portfolio:

	Date	Symbol	Order	Shares
0	2008-03-10	JPM	BUY	1000
1	2008-05-01	JPM	SELL	1000
2	2008-07-15	JPM	BUY	1000
3	2008-10-02	JPM	SELL	1000
4	2008-11-21	JPM	BUY	1000
5	2008-12-08	JPM	SELL	1000
6	2009-01-20	JPM	BUY	1000
7	2009-02-06	JPM	SELL	1000
8	2009-03-09	JPM	BUY	1000
9	2009-05-08	JPM	SELL	1000
10	2009-07-10	JPM	BUY	1000
11	2009-10-15	JPM	SELL	1000

The plot below shows the portfolio values changes in sample period. Red line curve shows 6 holding periods. During each holding period, the portfolio value moves as the price changes.

Between each holding period, the portfolio stays same as the previous value, because no stock is held at this time. It clearly shows that optimal strategy portfolio has a higher value $1,087,900 at the end of the period than bench mark portfolio value $1,001,230.



From the comparison table below, optimal portfolio has better stats than bench mark portfolio.

=======Bench Mark Portfolio Stats=======	=======Optimal Portfolio Stats=======
Cumulative Return: 0.001230	Cumulative Return: 0.0879
Standard Deviation of Return: 0.00161268	Standard Deviation of Return: 0.00134091
Average Daily Return: 0.00000374	Average Daily Return: 0.00020894
Bench Mark Portfolio Value: 1001230.0	Optimal Portfolio Value: 1087900.0

Manual Rule-Based Trader

In this manual rule-based portfolio, I combine my indicators to decide my trading strategy.

Rule#1, I use Bollinger Band indicator to set a BUY order at day *t,* when price is lower than lower band at day *t-2* and gets back to cross lower band at day *t-1*. In another word, I decide to BUY stock today when its price line cross the lower band yesterday from outside to the central band. Similarly, I set a SELL order when price is higher than upper band at day *t-2* and gets back to cross upper band at day *t-1*. In another word, I decide to SELL stock today when its price line cross the upper band yesterday from outside to the central band.

Rule#2, I calculate price/SMA ratio to indicate a BUY strategy when ratio value is greater than 1.05 and a SELL strategy when ratio value is less than 0.95.

Rule#3, I compare EMA indicator for day *t-1* and day *t-2* to see the trend of the price. If EMA at day *t-1 is higher than EMA at day t-2,* it indicates the price will go up and vice versa.

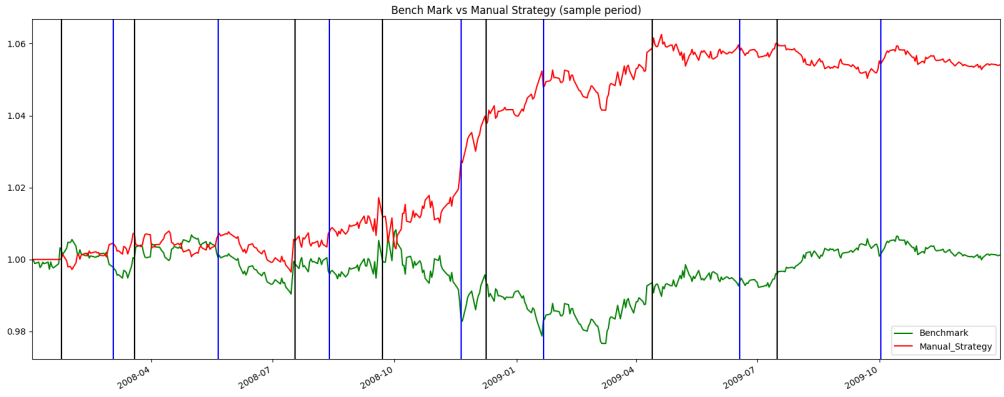
Rule#4, I use Volatility indicator to check the volatility of daily return at day *t-1.* If volatility is low, it indicates the daily return will not change too much for the near future. In this case, my strategy based on historical data will be riskless. Otherwise, when volatility is high, it indicates the daily return may change a lot for the coming days. In this case, my strategy may be risky.

Constraints:

To follow the holding constraints, I initial variable holding=0 and use it to count the current holding of number of shares by following the rules described in the table below to make sure the current holding will change within the proper range:

current holding	-1000	0	1000
BUY	2000	1000	0
SELL	0	1000	2000

I combine 4 rules to create my trading strategy when all conditions are met. And together with the limitation of number of holding shares, it turns out picking 7 days to buy and 7 days to sell. As plot shown below, Manual strategy portfolio outperforms the benchmark portfolio at the end of sample period with total portfolio value $1,054,123.15 after deducting $9.95 commission fee per transaction and 0.5% impact charges on trading value.

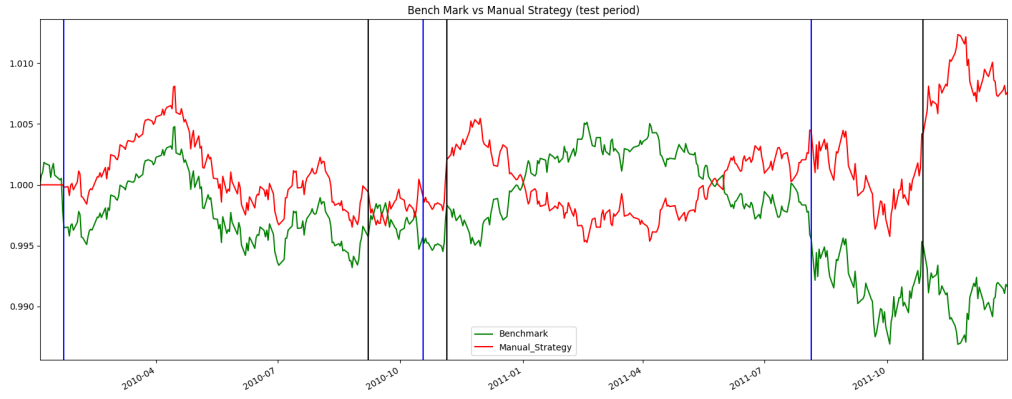


==Bench Mark Portfolio Stats Sample Period=	=Manual rule-based Portfolio Stats sample period
Cumulative Return: 0.00123	Cumulative Return: 0.05391753
Standard Deviation of Return: 0.00161268	Standard Deviation of Return: 0.00155834
Average Daily Return: 0.00000374	Average Daily Return: 0.00010861
Bench Mark Portfolio Value: 1001230.0	Manual rule-base Portfolio Value: 1054123.15

The table above shows the stats for both benchmark portfolio and manual rule-based portfolio. Manual rule-based portfolio beat the benchmark portfolio and gain more profit at the end of period. From the stats compared with optimal portfolio, my strategy beats the benchmark but does not beat the optimal portfolio. Rules may be improved.

Comparative Analysis

For comparative analysis, I apply my manual rule strategy to test period and compare the performance with benchmark portfolio. From the plot below, my strategy has 3 BUY orders and 3 SELL orders. It outperforms the benchmark and makes profits at the end of the period.



==Bench Mark Portfolio Stats test period==	==Manual Rule-based Portfolio Stats test period==
Cumulative Return: -0.00834	Cumulative Return: 0.00777838
Standard Deviation of Return: 0.00081279	Standard Deviation of Return: 0.00080339
Average Daily Return: -1.63202259e-05	Average Daily Return: 1.6135001e-05
Bench Mark Portfolio Value: 991660.0	Manual Rule-based Portfolio Value: 1007580.15

The table above shows the stats for both benchmark portfolio and my strategy portfolio during the test period. Stock price decreases during the test period. That is the reason why benchmark portfolio has a negative cumulative return, average daily return and a loss of portfolio value at the end of period. This bear trend together with holding limitation effect my strategy portfolio performance. Less trading orders made and less profits compared to sample period.